APPENDIX G. EMERGENCY PREPAREDNESS

Each installation where criticality accident alarm systems are installed shall have an emergency preparedness plan, program, and capabilities to respond to credible nuclear criticality accidents. In addition, organizations, local and offsite, that are expected to respond to emergencies shall be made aware of conditions that might be encountered, and they should be assisted in preparing suitable procedures governing their responses.

G.1 Emergency Plan. An emergency plan shall be developed and written to describe the site's emergency response to credible perceived nuclear criticality accidents and emergencies having a potential effect on nuclear criticality safety (e.g., fires). The emergency plan shall describe the personnel, organizations, facilities, and equipment that shall be available and the actions that should occur in an emergency. Potential nuclear criticality accident locations should be identified in the plan. The Emergency Plan should include the following elements:

G.1.1 Emergency organization. The plan shall include a description of the emergency response organization including the role and function for each position. A chart depicting the chain of command and working interrelationships between positions should be provided. The plan shall include the line of succession for assuming the responsibility of the Emergency Coordinator (EC). Information should be included on how the organization will be augmented by other personnel within that facility, persons from other facilities, and government agencies. In this section of the plan, reference shall be made to provisions for support from local fire departments, rescue squads, ambulance services, and hospitals.

G.1.2 Emergency notification. The plan shall include a description of the process used by the site to notify emergency response personnel, government agencies, and both DOE HQ and the DOE Field Element. This should include a brief description of the expected immediate actions of the site personnel and reflect the actions of the governmental agencies as described in their response plans. Notification formats may be included.

G.1.3 Immediate protective action requirements. The plan shall describe the immediate actions of all personnel in the area of a nuclear criticality accident. Provisions shall be made for immediate evacuation, designating of assembly stations, accounting of personnel, and the immediate actions of the emergency response personnel. The plan shall include provisions for responses to simultaneous credible emergencies (e.g., fire, injury, etc.).

G.1.4 Emergency response facilities, equipment, and supplies. The plan should include a description of the facilities, equipment, and supplies, and the activation sequence of these facilities. The facilities, equipment, and supplies shall be readily accessible and available.

G.1.5 Fire fighting. The installation emergency response plan shall make provisions for the control of fire fighting in fissionable material control areas for which nuclear criticality safety could be jeopardized by fire fighting activities (e.g., use of high pressure water streams or water deluge systems).

G.1.6 Radiological assessment and protection. The plan shall include a description of the basis for onsite and offsite radiological dose assessment for direct radiation and for airborne and liquid releases. Guidelines for limiting radiation exposure to emergency response personnel and for

authorizing maximum dose, in special situations, shall be provided. Emergency decontamination plans and limits should be provided for facilities, equipment, and personnel.

G.1.7 Termination, re-entry, and recovery. The plan shall include a description of the recovery organization including roles and responsibilities of each member and how the emergency organization transfers appropriate responsibility to the recovery organization.

The plan shall include a description of considerations for downgrading or terminating the emergency and entering into the recovery phase.

G.1.8 Public information program. The plan should include a description of methods used to ensure coordinated, timely, and accurate release of information to be disseminated to the public.

G.1.9 Program maintenance. The plan shall include a description of methods for maintaining all emergency response capabilities.

G.1.10 Training, drills, and exercises. The plan shall include a description of programs for training personnel, including emergency response teams and other appropriate personnel. The plan shall include a description of drills and exercises to be conducted on a periodic basis.

G.1.11 Review. The plan shall include a statement requiring an annual review, and be updated as necessary.

G.1.12 References. The plan shall include a list of documents used as a basis for plan and procedure development.

G.1.13 Appendices. The plan shall include appendices that contain the following:

- agreement letters - a list of agreement letters the facility maintains with other organizations; this list should include
  - local hospital(s),
  - local ambulance service(s),
  - local fire department(s),
  - local law enforcement agencies,
  - appropriate government agencies (local, state, federal, foreign, tribal), and
  - other supporting organizations (subcontractors, other facilities);
- supporting agency plans - a list of the appropriate supporting emergency response plans; and
- emergency plan implementing procedures - a list of the emergency plan implementing procedures.

G.2 Administrative Responsibilities. The responsibilities of the installation management and emergency assistance/response personnel should be provided in the emergency plan and address the following:

G.2.1 Installation management. Installation management shall

- ensure that an Emergency Response Plan and implementing procedures are established and are subject to periodic review,
- ensure that an emergency response organization exists,
- ensure that emergency response training and periodic retraining is provided to the emergency response organization and facility personnel,
- ensure that training relevant to the Emergency Response Plan and its implementing procedures, including drills and exercises, is performed,
- ensure safe egress of all, including disabled, personnel,
- ensure that a personnel assembly station is, or stations are, established,
- ensure the timely accounting of personnel, including employees, vendors, visitors, etc.,
- ensure that an Emergency Operations Center (EOC) is established,
- provide timely and complete information to the technical staff, and
- ensure the availability of instrumentation and procedures for determining the radiation fields in the Operations Support Center, the assembly areas, and in the evacuated areas following a perceived nuclear criticality accident.

G.2.2 Technical staff. The technical support staff (e.g., health physics, fire protection, criticality safety, industrial hygiene, etc.) has responsibilities in the areas of pre-emergency planning, emergency response, and post-emergency activities.

G.2.2.1 Planning. The technical staff shall assist in development of the installation emergency plan by

- identifying locations of potential nuclear criticality accidents and the associated accident characteristics,
- designating areas to be evacuated,
- providing criteria for the personnel assembly stations, and for the relocation of personnel to the alternative personnel assembly station,
- providing guidance in establishing evacuation routes, and ensuring that these routes are clearly designated,
- recommending instrumentation requirements for the perceived nuclear criticality accident, and ensuring that these instruments are kept in a state of readiness and are available, and
- maintaining a level of readiness for emergency response.

G.2.2.2 Emergency response. The technical staff shall assist in the emergency response by

- assisting the emergency coordinator in response to the perceived nuclear criticality accident,

- assisting in the orderly evacuation of personnel from the designated evacuation areas, and in the accountability of personnel at the designated assembly station,

- evaluating the potential for a recurrence of the perceived nuclear criticality accident, and promptly informing the emergency coordinator for proper response,

- assisting in the re-entry and rescue effort, including determining the radiation field and dose level, etc., and

- advising facility management about the maintenance of a safe shutdown condition during re-entry.

G.2.2.3 Post-emergency. The technical staff shall assist in post-emergency recovery and remediation by

- evaluating the post-nuclear criticality accident, and recording and documenting any lessons learned, and

- including these lessons learned in the training and testing plan for emergency response.

G.3 Fire fighting. Water, the most often used fire fighting agent, is an efficient moderator and reflector of neutrons. In the absence of moderating materials such as water, relatively large masses of dry fissile nuclides such as powders or metals may be safely handled. If the presence of water is likely, however, some operations with dry fissile nuclides may have to be constrained, modified, or eliminated. The following provides a framework for the successful combination of fire fighting and nuclear criticality safety.

G.3.1 Water sprinkler coverage. Automatic water sprinkler coverage shall be provided throughout a facility except in areas where the potential for nuclear criticality or other hazards specifically precludes use of water or where halogen gas, or similar fire suppression gas, systems are required to reduce equipment damage. In this regard, reasonable nuclear criticality safety efforts shall be taken in facility design and operation to allow the use of water sprinkler systems before a decision is made to exclude sprinklers.

G.3.2 Alternative extinguishing systems. When the use of water sprinkler coverage is precluded because of the potential for nuclear criticality or other hazards, nonaqueous extinguishing systems (i.e., inert gas, carbon dioxide, high-expansion foam, or halogenated organics) shall be used.

G.3.3 Avoidance of criticality accidents. Neither automatic fire protection systems nor manual fire fighting measures should be a credible cause of an inadvertent criticality accident.

G.3.4 Exclusion of flammable materials. The presence of combustible/flammable materials shall be minimized in areas in which the potential for a criticality accident exists.

G.3.5 Water usage restriction training. Any facility that has restrictions on the use of water for fire fighting shall include such restrictions as part of the routine nuclear criticality safety training for that facility.

G.3.6 Compliance with DOE Order 6430.1A. Nonreactor nuclear facilities and reactor fuel storage/handling facilities should comply with DOE Order 6430.1A, referenced in section 2.1.18, with respect to fire fighting requirements.

G.3.7 Posting requirements for fire fighting. For fissionable material areas, processes, or equipment that require fire fighting restrictions (e.g., the exclusion of water and use of graphite, exclusion of high pressure water streams, etc.), appropriate postings shall be developed and displayed that clearly and concisely portray such restrictions. The CSO and Fire Department shall review and approve such postings. These readily observable postings shall be located so as to alert and to provide guidance to fire fighting personnel at such locations (e.g., entrances to moderation controlled, "dry," process operating areas, adjacent to or on process operations hoods used to ensure dryness of fissile materials).

G.3.8 Posting durability. Special fire fighting postings shall be constructed of noncombustible material.

G.3.9 Posting locations. Fire fighting postings shall be located at the entrance to areas in which fire fighting restrictions exist. Specific hoods, cabinets, gloveboxes, or other equipment that may be subject to fire fighting restrictions shall be posted as well as the entry to the room in which they exist. To the extent possible, fire fighting postings for nuclear criticality safety shall be located at a height, and shall be of sufficient size, to be readily apparent. Posting locations and methods should consider the conditions that fire fighting personnel are expected to encounter when fighting a fire.

G.4 Emergency Evacuation. The emergency plan shall describe the immediate evacuation zones and routes that are based upon the planning support of the technical staff (see section G.2.2.1). This portion of the emergency plan should include the following:

G.4.1 Immediate evacuation zones (IEZ). An IEZ outer boundary shall be established, based upon the documented accident analysis provided from section G.2.2.1 and the requirement that the prompt dose should not exceed 5 rad (0.05 gray).

G.4.2 IEZ intersection with work areas. Where an IEZ boundary intersects an occupied work area, the entire work area should be included in the IEZ.

G.4.3 Evacuation routes. When an alarm is activated, all personnel within the IEZ should evacuate at once to their prescribed assembly station(s) by predetermined evacuation routes. Such an evacuation will avoid delays due to indecision and accordingly will reduce personnel exposure.

G.4.4 Evacuation of disabled persons. Provisions shall be made for the immediate evacuation of any disabled person that is permitted in an IEZ.

G.4.5 Risk reduction. Evacuation routes should minimize the total risk considering all potential hazards (e.g., industrial, chemical, and radiation).

G.4.6 Clear egress. Sufficient means of egress shall be provided to allow for rapid and unobstructed evacuation of personnel.

G.4.7 Security crash doors/gates. Personnel safety shall take precedence over security considerations. Accordingly, where security restraints block evacuation routes, crash doors/gates shall be provided.

G.4.8 Radiation monitoring and personnel relocation. Radiation levels shall be monitored in all occupied areas adjacent to, but outside, the IEZ as soon as possible after activation of the criticality alarm signal. Provisions shall be made for relocating people from any occupied area where the total dose rate exceeds 100 mR/hr.

G.4.9 Evacuation training. All personnel who may be in the area to be evacuated shall be trained in evacuation methods and informed of routes and assembly stations, or shall be escorted by trained personnel while within the area to be evacuated.

G.5 Emergency Assembly Stations. In preparation for credible nuclear criticality accidents, the following provisions shall be made for emergency assembly stations.

G.5.1 Identification. Personnel assembly stations shall be clearly designated and identified.

G.5.2 Lighting. Lighting and backup lighting should be provided for assembly stations.

G.5.3 Protection from radiation. Assembly stations shall be located or designed to minimize the radiation exposure to evacuated personnel.

G.5.4 Coordination of activities. Provisions shall be made to permit communications between the emergency coordinator and the assembly stations for coordinating activities, reporting personnel accountability results, etc.

G.5.5 Radiation field monitoring. Instrumentation and procedures shall be provided for determining the radiation dose rate at the assembly station.

G.5.6 Relocation criteria. Procedures shall include instructions and criteria for relocation of personnel to the alternative assembly station in the case of high radiation or other conditions that may affect personnel safety at the primary assembly station.

G.5.7 Identification of irradiated personnel. Provision shall be made for immediate identification of exposed individuals and injured personnel at the assembly station. Procedures should include the use of personnel dosimetry and instrumentation to determine radiation exposures.

G.5.8 Identification of contaminated personnel. Provision shall be made for identifying contaminated individuals.

G.5.9 Medical treatment. Medical treatment of exposed and injured personnel at the assembly station and transport to medical facilities should be provided as necessary.

G.5.10 Personnel accountability. Provision shall be made for accountability of personnel at the assembly station.

G.5.11 Information gathering. Information concerning the perceived criticality should be obtained from evacuated personnel at the assembly station. This information may include location of personnel at a time of alarm, evacuation route followed, and observations.

G.5.12 Communications. A means of communicating between the Emergency Coordinator and the assembly stations shall be provided.

G.5.13 Abandonment of assembly station. Personnel should remain at the assembly stations until instructed otherwise by the Emergency Coordinator.

G.6 Re-entry, Rescue, Stabilization, and Recovery. The following guidance is provided regarding re-entry into an IEZ for rescue, stabilization, and recovery from a real or perceived nuclear criticality accident. Additional guidance about rescue team radiation exposures is provided in DOE Order 5480.11 ¶ 9.p.(3)(a-c), "Saving of Human Life," "Recovery of Deceased Victims," and "Protection of Health and Property."

G.6.1 Re-entry. Re-entry into IEZs shall be performed under controlled and preplanned conditions in order to minimize injury and radiation exposure of personnel. The following provides guidance in the performance of re-entries.

G.6.1.1 Authority. All personnel entries made during any rescue and recovery activities shall be initiated only under specific instruction from cognizant management at the emergency site (e.g., the Emergency Coordinator).

G.6.1.2 Personnel qualification. Re-entry during the emergency should only be made by trained individuals who are familiar with facility operations and have an understanding of the hazards involved.

G.6.1.3 Re-entry criteria. Re-entry into the IEZ should be made only if the preliminary radiological survey measurements indicate that the critical system is terminated, or that the event was a false alarm. In the unusual case where it is determined that the critical system is continuing, and will cause excessive damage or significant releases of radioactivity if allowed to continue, an early re-entry effort to disable the system could be considered. However, the method for disabling a cycling critical system shall be planned before being implemented.

G.6.1.4 Purpose of initial re-entry. The primary purpose of the initial re-entry into the IEZ shall be to conduct a preliminary radiological survey because early emergency actions are primarily dictated by radiological conditions. The objectives of the preliminary radiological survey should be to (a) determine if high radiation fields exist, and (b) locate the general area of the source. The results of the preliminary radiological survey will aid in the determination as to whether a criticality has occurred and, if it has, whether it is terminated.

G.6.1.5 Robotics. Robotics may be utilized for re-entry.

G.6.2 Rescue. The following provides direction in performing rescue operations within an IEZ.

G.6.2.1 Minimization of radiation exposures. Rescue actions shall be controlled to prevent unnecessary radiation exposure.

G.6.2.2 Initiation of rescue. Rescue actions should only be initiated after the critical system has permanently terminated and its location is known.

G.6.2.3 Continuing emergency. If personnel need to be rescued from an area near a potentially reoccurring accident, the rescue shall be planned, within reasonable time constraints, and approved by the Emergency Coordinator. Rescuers should not be exposed to life-threatening radiation doses.

G.6.2.4 Rescue team. Rescue actions that require early re-entry into the IEZ should be performed by a team (i.e., more than one person) whenever practicable. The approach route taken by the rescue team should depend upon the known location of the criticality occurrence. The approach route should be planned to provide (a) a clear view of the rescue area without close proximity to the criticality source, and (b) an unrestricted retreat route.

G.6.2.5 Extended rescue actions. During all rescue actions, stay-time in any high radiation fields shall be controlled and shall be kept to a minimum. If rescue actions require extended stay-time in a high radiation field, more than one rescue team should be used to limit the radiation exposures of individual rescue team members. Only very serious or life-threatening injuries (e.g., arterial bleeding) should be treated in the general area of the criticality source. Whenever practicable, injured personnel should be moved at least fifteen feet away from the criticality source before immediate first aid action is administered. All other first aid actions should be performed after the injured personnel have been moved to another location away from the general area of the criticality source.

G.6.2.6 Irradiated personnel treatment. Personnel who have received serious injuries or high radiation exposures shall be promptly identified and transported to an agreement hospital, in accordance with the emergency plan. Injured personnel who have been highly irradiated (i.e., activated) or contaminated with radioactive material, should be accompanied to the hospital by a person trained and equipped to perform the necessary radiation monitoring.

G.6.3 Stabilization. The following guidance is provided for stabilizing the system in a subcritical condition.

G.6.3.1 Ensuring of subcriticality. The technical staff shall determine that the system is subcritical and shall advise management of the means for ensuring a safe condition for affected equipment. This may include placing the fissionable material in a favorable geometry, diluting the fissile solution below a critical concentration, or using neutron poisons to obtain the desired negative reactivity. Consideration shall be given to potential increased exposures to personnel involved in stabilization and recovery activities.

G.6.3.2 Use of neutron poisons. If emergency plans call for use of neutron poisons for ensuring subcriticality, then an inventory of the absorbers shall be maintained sufficient for the worst credible accident. Consideration shall be given to potential chemical reactions between neutron poisons and other involved chemical agents.

G.6.4 Recovery. The recovery process shall provide for the study and documentation of the accident to determine its cause and future preventive measures.

G.6.4.1 Documentation of the scene. Every practical effort shall be made to preserve the original condition of the accident scene without compromising the safety of personnel. Photographic

documentation should be made of the scene and affected equipment. Chemical, metallurgical, and radiological analyses should be made, as practical.

G.6.4.2 Investigation. Management shall initiate an incident investigation, including an investigation of false alarms that may have led to a perceived criticality. Management should secure operational and data logs and records of the affected facilities and equipment for use in the incident investigation. Management shall disseminate "lessons learned" to all affected parties. Management should take all reasonable and practicable steps to prevent the recurrence of a similar incident.

G.6.4.3 Investigative recreation. The incident investigation team should re-interview incident witnesses. A dramatic recreation of the scene prior to, during, and after the incident may be made to aid in the determination of the cause of the incident and to identify potential improvements to the emergency response program. The team shall include line management of the area where the incident occurred and shall include nuclear criticality safety personnel.

G.6.4.4 Decontamination. Management shall ensure that necessary decontamination during recovery is accomplished in an orderly, planned fashion. Use may be made of remote techniques or robotics in the decontamination process.

G.6.4.5 Minimization of radiation exposures. Management shall provide the means for monitoring radiation exposure of personnel involved in recovery operations. The technical staff shall have the ability to estimate radiation dosage to personnel and the general public during recovery operations. Personnel radiation exposures shall be maintained as low as reasonably achievable.

G.7 Fixed Nuclear Accident Dosimeters (NADs). Nuclear accident dosimeters shall be used for estimating the magnitude of a nuclear criticality accident, determining free air radiation dose values at their locations, and for supplementing personnel nuclear accident dosimeter information to determine more precisely radiation exposures to personnel. The following information shall be taken into consideration in the selection and placement of NADs.

G.7.1 Placement and numbers. NADs shall be located in areas where a criticality accident is credible and in surrounding areas where exposure to personnel is possible. NADs shall be located in sufficient numbers to determine the neutron fluence as described in DOE 5480.11 ¶ 9.q.(2). The exact placement and numbers of NADs shall be determined by the NCS staff and Health Physics with the following considerations as a guide:

- locations of potential criticality accidents,
- location of personnel (i.e., break rooms, operating stations, offices, etc.)
- intervening shielding, and
- retrievability following a criticality accident.

G.7.2 Documentation. Locations of NADs shall be documented, and periodic inspections shall be required to ensure that they have not been removed or compromised.

G.7.3 Facility modifications. Any change in the building, the process, or procedures shall be reviewed as to the effect on the NAD system.

G.8 Training. Emergency preparedness training shall be conducted on a periodic basis and should include the use of exercises, drills, classroom training, and table-top exercises.

G.8.1 Exercises. A formal program of criticality response exercises shall be established, documented, and maintained. Exercises shall be conducted at least annually to test the capabilities of the emergency management and emergency response organizations and to reinforce emergency training. Exercises may be held in conjunction with a drill. Requirements for exercises follow.

G.8.1.1 Frequency. Facility personnel, including each member of the emergency response organization, should participate at least annually in a planned and scheduled nuclear criticality accident exercise to reinforce proper actions and response.

G.8.1.2 Involved personnel. Exercises shall involve emergency management, emergency response, nuclear criticality safety, radiation protection, and offsite emergency response organizations that are expected to respond if an actual nuclear criticality accident occurred at the facility.

G.8.1.3 Scenario. Exercises shall include a preplanned, realistic scenario involving a simulated nuclear criticality accident and should have pre-identified objectives that define the aspects of emergency response to be tested or reinforced.

G.8.1.4 Control. Exercises should be planned and controlled by an individual, or group of individuals, who is not a participant (player) in the exercise.

G.8.1.5 Information. Exercise participants shall be given no information regarding the nature or details of the scenario prior to commencement of the exercise. Participants shall not be prompted to take action by controllers.

G.8.1.6 Agency notification. Notifications shall be made to the appropriate outside agencies during the exercise to advise them of the simulated emergency.

G.8.1.7 Evaluations. Exercises should be evaluated by observers, and the evaluation results shall be reported to the exercise participants.

G.8.1.8 Critiques. Exercises should include a critique given by the participants, observers, and controllers.

G.8.1.9 Corrective actions. A formal program that documents and tracks corrective actions identified during the critique should be maintained.

G.8.2 Drills. A formal program of training and criticality drills shall be established, documented, and maintained for the Emergency Response Organization.

Drills shall be conducted at least annually to familiarize facility personnel with the alarms, evacuation routes, assembly areas, and personnel accountability and emergency evacuation procedures relative to a nuclear criticality accident. Drills shall be announced in advance. Annual drills may be conducted during an annual exercise. All facility personnel shall be required to participate.

G.8.3 Classroom Training. A formal program of criticality accident response classroom training shall be established, documented, and maintained. Elements of the program are as follows.

G.8.3.1 Facility personnel. Facility personnel who are expected to respond to an emergency alarm shall be trained at least annually regarding facility layout, recognition of the nuclear criticality accident alarm, the established evacuation route, the location and operation of the personnel assembly area, and the accountability of personnel.

G.8.3.2 Response personnel. Emergency management, emergency response, security, and offsite emergency response personnel shall be trained at least annually regarding site specific emergency procedures (including IEZs), concerns associated with a nuclear criticality accident, and their respective duties and responsibilities during a nuclear criticality accident or a potential nuclear criticality accident.

G.8.3.3 Visitors. Visitors to the facility shall be briefed regarding emergency response prior to entering the facility.

G.8.3.4 Re-entry teams. Training regarding re-entry shall be provided annually to personnel expected to serve on a re-entry team. Recovery instruction shall be provided prior to a recovery effort for personnel expected to serve on a recovery team.

G.8.3.5 Nuclear criticality safety organization (CSO). The nuclear criticality safety organization staff shall be trained, as a minimum, regarding

(a) its duties and responsibilities during a nuclear criticality accident or a potential nuclear criticality accident,

(b) its interaction with management during a nuclear criticality accident or a potential nuclear criticality accident, and

(c) re-entry procedures, especially as they relate to nuclear criticality safety considerations.

G.8.3.6 Teamwork. Training should emphasize teamwork among members of the various management and response organizations.

G.8.3.7 Training program design. Training should be performance-based, e.g., to include a needs analysis, the development of learning objectives, implementation based on need, and an evaluation.

G.8.4 Table-Top Exercises. Table-Top exercises shall be conducted at least annually to test the capabilities of the emergency management organization and to reinforce the emergency training they have received. The table-top exercises should include the following elements.

G.8.4.1 Scenario. Table-Top exercises shall include a preplanned, realistic scenario involving a simulated nuclear criticality accident.

G.8.4.2 Objectives. Table-Top exercises shall have pre-identified objectives that define the aspects of emergency response to be tested or reinforced.

G.8.4.3 Control. Table-Top exercises shall be planned and controlled by an individual or group of individuals who are not participants (players) in the exercise.

G.8.4.4 Information. Table-Top exercise participants shall be given no information regarding the nature or details of the scenario prior to commencement of the exercise. Participants shall not be prompted to take action by controllers.

G.8.4.5 Emergency management personnel. Table-Top exercises shall involve emergency management personnel who would be expected to direct emergency operations during a real emergency.

G.8.4.6 Evaluations. Table-Top exercises shall be evaluated by observers, and the evaluation results shall be reported to the exercise participants.

G.8.4.7 Critiques. Table-Top exercises shall include a critique given by the participants, observers, and controllers.

G.8.4.8 Corrective actions. A formal program that documents and tracks corrective actions identified during the critique shall be maintained.